Attitudinal Changes Toward Mathematics Through Differentiated Teaching Practices

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Abstract

The purpose of this research project was to see if the implementation of differentiated teaching practices changed students' attitudes toward the study of mathematics. A pre-test of students' attitudes toward mathematics was given to a control group of 16 students and a treatment group of 15 students. Once attitudes were measured, the treatment group was tested with the Triarchic Theory of Intelligences test created by Robert Sternberg to assess the students' learning styles. The treatment group was also tested with the Modality Preferences Instrument to assess the students' sensory preferences. Once learning styles and modality preferences were identified in the treatment group, all subsequent math lessons were differentiated to address the learning styles or modalities of the treatment group. The control group continued to receive direct instruction with no differentiation for math instruction. Findings of this research showed no significant change in students' attitudes toward the study of mathematics in either the treatment group or the control group. However, more extensive research is needed to determine if over a longer period of time, differentiated instruction changes students' attitudes towards the study of mathematics.

Chapter I
Introduction and Statement of the Problem

The hypothesis that differentiation of fourth grade math instruction changes student perceptions of the discipline is the focus of this action research project. It was my opinion that students that are actively engaged in the study of mathematics, will express positive attitudes toward the subject. Students who had a negative opinion about the study of mathematics would have improved perceptions with the implementation of differentiated lesson plan implementation. In the past I have taught third, fourth, and fifth graders of both genders and many different races and ethnicities. I have also had opportunities to teach on both the West Coast and East Coast and in public and private schools. I have taught varying levels of economic strata and universally, with all aforementioned groups, I have found that three general perceptions exist: that the study of mathematics is boring, that much math has no relationship to the students themselves, and that boys are generally better at math while girls are better at language arts. This study does not seek to explore the causality of these existing perceptions. This project seeks to identify student attitudes towards the study of mathematics and to discern whether or not the implementation of differentiated teaching practices would impact those perceptions. There are many potential sources for students' attitudes toward the study of mathematics, but according to Nosek, Banaji, and Greenwald (1998), one potential source is the classroom teacher. I am one of two fourth grade classroom teachers in a private tuition based school in Lynchburg, Virginia. My classroom, which was the treatment classroom, consisted of eight girls and seven boys. The students range from socioeconomically upper middle to high upper class backgrounds. One student is Asian American and the remaining students are white. The other teacher's classroom,

which was the control group, consisted of eight girls and eight boys. The students range from socio-economically upper middle to high upper class backgrounds. All of the students are white.

As one of the two fourth grade teachers I planned to implement differentiated teaching strategies to see if a significant change in the perception of math studies occurred. By assessing students' learning styles utilizing Robert Sternberg's, "Triarchic Theory of Intelligences" test and a modality preferences instrument. Students may develop a deeper understanding of the mathematics curriculum through differentiated instruction and subsequently reflect that knowledge through standard curriculum assessment. Will their perceptions of mathematics change? The non-treatment group will be taught the standard Everyday Math curriculum primarily through direct instruction and the groups compared for their perceptions of mathematics.

Through the analysis of past studies, research projects, articles, and my own industry experience I have found, both as a parent and professional educator, that there exists a negative perception of the study of mathematics. According to Hyde, Fennema, and Lamon (1990), it has been found that students in grades kindergarten through twelve feel that, regardless of their academic achievement, their personal confidence can be low, the usefulness of math content is questionable, that math is perceived as primarily a male domain, or that teachers' attitudes aren't conducive to their personal success. The instrument that was used in this project measured student attitudes in each of these mentioned categories. The instrument used was the Modified Fennema-Sherman Mathematics Attitude Scale. A study by Campbell and Storo (2004) suggests that the stereotype of women's roles in mathematics becomes increasingly more pronounced and

that opinions begin to change, as children become older. This study attributes the perpetuation of these trends to teachers, families, and societal biases across the spectrum of society regardless of race, ethnicity, or social-economic strata. Media and literary perpetuation of math as a complicated and enigmatic discipline are cited as sources of great influence.

My research began with the collection and summary of information as it relates to the topic of study, establishing whether or not other research has shown the existence of a negative perception toward the study of mathematics in elementary age students. My action research project began with two classroom samples, one consisting of sixteen children with eight boys and eight girls and the other of fifteen children with seven boys and eight girls. My sample groups consisted of thirty-one homogenous, upper to middle class, fourth-grade students that were placed into the school by a largely professional pool of parents. The school was a tuition-based school, with an admission test, and a focus on small class sizes. The sole math curriculum was Everyday Mathematics. There were two male fourth-grade teachers. The treatment classroom was taught with a Constructivist framework utilizing differentiated teaching methods. The non-treatment classroom was taught predominately through rote learning. I used the Modified Fennema-Sherman Attitudes Scales instrument as both a pre-assessment and post-assessment tool. This attitude assessment surveyed student's attitudes on four separate categories; personal confidence about subject matter [mathematics], usefulness of the subject's content, subject is perceived as a male domain, and perception of teacher's attitudes. The maximum score for each subject area is sixty points while the minimum score is twelve. After tabulating the pre-assessment results I implemented, a pre-designed, differentiated

math curriculum with the treatment group. At the end of a six-week marking period the two classes will again complete the assessment instrument to determine if there were any changes in student perceptions.

Upon completion of the action research, results were collected and computed. If the results indicate that by implementing differentiated instruction in a fourth grade classroom changes student's perceptions significantly then it can be surmised that through differentiated instructional practices student perceptions of the study of mathematics can be altered. If there is no change in perception then it can be surmised that differentiation of fourth grade math instruction does not change perception of the discipline.

The null states that differentiation of fourth grade math instruction does not change perception of the discipline.

Chapter II
Information and Resources

When considering the question of whether or not student perceptions toward the study of mathematics will change through differentiated instruction, one must first consider whether or not research has shown that there is an issue that exists with student perceptions. Multiple articles have been written and much research has been conducted to support the theory that students have a negative perception toward the study of mathematics. Research also shows that negative perceptions are most acute due to gender stereotypes that exist at every level of pre and post-secondary education. Some of the supporting research further explores the extenuating consequences of gender stereotyping within mathematics. This literature review will focus on student perceptions of the study of mathematics including the possible existence of gender stereotypes.

In research done for the IEA Third International Mathematics and Science Study (TIMSS), 1994-95 students' attitudes toward the study of mathematics correlated directly with the level of achievement which would, in turn, generate a positive or negative attitude toward the discipline. In more than a third of the countries the correlation between high achievement and positive attitude existed, although not all of these students reported feeling positive about the study of mathematics.

In research done by Nooriafshar and Maraseni (2006) identification of learning style (modal) preferences; and preferred method of learning facilitated success and subsequent positive attitudes toward the study of mathematics. The research indicates that of two groups studied, 85% regarded mathematics as an enjoyable subject while 15% regarded it as not enjoyable. It is noted that with an increased level of study mathematics is perceived to be a more enjoyable subject. Within the two study groups 38.8% of the

total students believe that the practical use of mathematics is very high, 51.3% regarded the practicality as high, and 10% regard the practical use of mathematics as low. Within the two groups 53.8% of the students believed that mathematics would factor into their future professions, 40% weren't sure, and 6.3% believed that mathematics would not factor into their professions. When learning style preferences were compared within the two groups 10% utilized verbal explanations, 80% utilized graphs, pictures, images, etc., and 10% utilized self-reading and asking of questions.

"A significant number (around 64%) of the total students had a preference for learning the concept before exploring the application."(p.4) Although the preference for learning methods between the two groups of students seems almost the same (in figures and numbers) a Chi-Square test for the statistical accuracy was performed. This test has shown that there is no statistically significant difference between the two groups of students even at 12% confidence level (Chi-Square 0.018, p=0.893). This test has statistically verified the strong similarity on learning method preference between the students of [the two groups]. These findings show that an increase of academic achievement as a result of differentiated instruction improves student attitudes towards the study of mathematics and mathematical by related material.

Gender also plays a role in student perceptions of the study of mathematics. In research done by Nose, Banaji and Greenwald (1998), findings indicate that women avoid mathematics and mathematic related subjects despite consistent achievement in these subject areas. The study found that,

"Over time, females filter out of mathematics and science at a much higher rate than males."(pg.10) The study supports this statement with concurring statistics ." While

the same in high school, female participation rates relative to males in mathematics and science begin to decline in college and continue to sink until, by the time women reach the workplace, they represent only 22% of employees in mathematical and scientific domains" (NSF, 1996, pg.11).

This study also finds that, "A similar decline for females is observed in mathematics performance. While no math performance differences are present between males and females in elementary and secondary school, by high school and college, differences favoring males emerge. These differences are greatest when considering highly selective samples such as gifted children (Hyde, Fennema, & Lamon, 1990, pg.3). On the Scholastic Aptitude Test, the most important math performance test of every aspiring student's life, males consistently outperform females. In fact, as many as 96% of the perfect or near-perfect scores on the SAT math test are achieved by males (Feingold, 1988)."

The study goes on to explore explanations to the findings, "A variety of mechanisms have been offered to explain these dramatic gender differences including: attitudes toward mathematics, the link between math and one's self-concept, and gender stereotypes about mathematics. Previous research has explored the role of attitudes and beliefs in participation and performance by using self-report measures. These measures require that the participant consciously reflect upon and report his or her attitudes and beliefs about mathematics."

To measure "implicit attitudes and beliefs about mathematics" the researchers utilized a procedure developed by Greenwald, McGhee, and Schwartz (1998) called the Implicit Association Test, or IAT. The test is described as,

"A computer-based reaction time measure test that provides an estimate of the degree of association between target concepts, like Math and Arts, and an evaluative dimension like pleasant/unpleasant. The test provides a relative measure of attitude. That is, attitudes toward mathematics are measured in the context of a contrasting category, for example, arts. A participant's response indicates an implicit attitude toward mathematics relative to his or her implicit attitude toward arts."

Given the test results the researchers form an index that they term "RAI" which stands for a relative attitude index. A positive number indicates a positive attitude toward mathematics relative to the arts and a negative result indicates, conversely, a negative attitude toward mathematics relative to the arts. The research concluded that for females tested the RAI was –193ms, which was greater than the tested males' score of –97ms. When research was conducted further the researchers found,

"For males, the positive link between self and male and a positive link between math and male predicts a positive link between self and math. However, for females, a positive link between self and female combined with a negative link between self and math to achieve balance. According to the "balance theory" for females the link between self and female requires that their relationship to a third variable, in this case math, must be the same polarity."

The culmination of the research states,

"(1) gender differences in attitudes toward mathematics can be revealed measuring outside of conscious control – females revealed more negative attitudes toward mathematics than males, (2) implicit relationships between self, math, and gender were consistent with Heider's balance theory that a relationship between self-perception,

the study of mathematics, and a subject's gender existed, (3) for females, gender identity was more strongly related to implicit beliefs about mathematics, and (4) for males, performance related to implicit beliefs about mathematics" (Nosek, Banaji, & Greenwald 1998).

If females feel that as a gender, they are limited in the study of mathematics, then it will affect their perception toward the study of the discipline. Also, male perception toward a female's role in the study of mathematics, will greatly affect their perception of the study of mathematics. What begins to be established is that women begin to identify the study of mathematics as a male pursuit. As women begin to associate success, enthusiasm, and subsequent proficiency toward the study of mathematics they, striving to fulfill a gender role, begin to identify with other courses of study leaving math a male domain.

In an article by Hammrich (2004), the author explores a gender inequity in mathematics instruction that perpetuates a gender stereotype that the study of mathematics is largely a male pursuit. In quoting Shirley M. Malcolm of the American Association for the Advancement of Science (AAAS) focuses on the root of the inequity.

"The effort to equalize educational opportunities is far from complete. [She notes], unlike some other nations, female students in the United States are legally guaranteed access to math and science courses. While our legal barriers to this education have been removed, there are often still barriers we face; these are what the author terms as, "Barriers of the Mind"" (Malcolm, 1997). Barriers of the mind are imbedded limiting factors in American math curriculum.

Ms. Hammrich goes on to state,

"Many barriers still exist that prevent females from participating fully in science and mathematics throughout their lives. Some of these barriers include the organizational characteristics of mathematics and science, female's perceptions of mathematics and science, and still others come from outside influences such as parents and teachers lack of encouragement in exploring fields such as math, science, and technology (AAUW, 1992; Kahle & Meece, 1994; and Baker & Leary, 1995)."

The inherent gender gap in mathematics originates from a lack of differentiation. "The first hurdle that girls face is being female. Research studies (AAUW, 1992; Baker & Leary, 1995; Evans, Whigham, & Wang, 1995; Hammrich, 1996; NSF, 1990; Wilson & Milson, 1993) have documented the wide gender gap in achievement scores between girls and boys in the areas of science and math. These authors assert that when girls are allowed to work in a manner that is intrinsic to their collective learning style, appropriate science and math learning takes place."

In conclusion the authors assert that certain points have become evident through research. "What became evident in all three programs, [*Sisters in Science, Daughters with Disabilities,* and *Sisters in Sport Science*], was that (a) parental behavioral expectations for their daughters have important implications for females' interest and achievement in science and mathematics; (b) intervention programs that are specifically designed to include role models have a strong and positive impact on females' achievement in science and mathematics and assist females to identify with science and mathematics as possible areas of study or employment; (c) program interventions evolve in stages of development, growth, and change. In order to promote the sustained success of females in science and mathematics there must be a conscious effort to provide support

for collaboration among schools, parents, and the community as ideas for useful strategies are developed, implemented, and evaluated" (Hammrich, 2002).

In a study by Cambell and Storo (2004), the authors immediately address sexual stereotypes by identifying sexual assumptions.

The authors state that, "Knowing someone is a man tells us nothing about whether his math skills reflect those of an Einstein or a math phobic. Sex is not a good predictor of academic skills, interests or even emotional characteristics."

Given a bar graph, as supporting evidence, on a range from 0 to 0.6 on relationship (correlation) High School GPA vs. College GPA scored approximately 0.58, Gender vs. Quantitative Skills scored approximately 0.1, Gender vs. Verbal Skills scored approximately 0.1, and Gender vs. Aggression scored approximately .13. The range indicates a scale of 0 (no relationship) to 1 (a perfect relationship). A one would indicate the correlation between birth and death.

The authors continue, "The relationship between sex and quantitative skills is about .1 as is the relationship between sex and verbal skills. This is a very low relationship which means that if all we know about you is that you are a woman, then we don't know if your quantitative (or verbal skills) are high, low or in between. The research goes on to establish that there is little difference between male and female proficiency in mathematics,

"Differences between individual girls or between individual boys are much greater than those between the "average" girl and the "average" boy. Yet we tend to generalize from the "average" girl or boy to individuals. And averages can be very deceiving. The average temperature of Oklahoma City is 60 degrees – but that tells us

little about what the temperature is going to be on any specific day – particularly since in Oklahoma City the temperature can range from –17 to 113. Similarly, knowing that in 1992 the National Assessment of Education Process (NAEP) math achievement score of the average 17-year-old girl was 297 out of 500 and for the average 17-year-old boy was 301, tells us little about the math achievement of individual girls and boys."

The authors go on to identify four general "myths" and the effects they often have on females who are or are endeavoring to study mathematics,

"I. Myth: "Real" women don't do math.

Related myths: You're too pretty to be a math major. Women are qualitative; men are quantitative.

Results: High school girls who think of math as a "male thing" is less likely to go on in math and are less likely to do well in math.

Girls are much less apt than equally talented boys to go into math-related careers including engineering and the physical sciences.

II. Myth: There is a biological basis for sex differences in math.

Related myths: There is a sex-linked math gene. Hormones cause everything.

Results: Parents have lower expectations for girls in math and science. Some educators use the "math gene" as an excuse for their own gender-biased classroom behaviors.

Biology is used to justify the smaller number of girls on math/science teams and the smaller number receiving math/science awards.

III. Myth: Girls learn better from female teachers.

Related myths: Role models must always be of the same sex as the student.

Results: Some female teachers feel that being a woman is enough to encourage girls, and

it isn't necessary to do anything else. Some male teachers feel that it isn't possible to reach girls so it isn't necessary to try. Some adults and students feel that girls avoid classes taught by men.

IV. Myth: It is not necessary to look at the interaction of gender and race when dealing with girls in math and science.

Related myths: If something applies to White girls it also applies to African American and Hispanic girls. If something applies to African American boys it also applies to African American girls.

Results: There is little research about African American and Hispanic girls and about the best ways to encourage them in math and science. There is potential for African American and Hispanic girls to be ignored and to feel invisible."

Stereotypes greatly affect an overall self-perception of a group by people within the group. Stereotypes also affect attitudes of people not within the group. These perceptions apply to gender stereotypes and the study of mathematics. The authors end their research by summarizing stereotypes: it is a stereotype if it ascribes characteristics to an individual based solely on group membership. For example, it is a stereotype to assume a tall thin young African American male is a basketball player or that an Asian student is good in math. It's probably a stereotype if it describes how girls and boys are "supposed" to be. For example, the statement that "Susie will be better than Ed at babysitting because she is a girl" is a stereotype. It's probably a stereotype if a book, toy or tool is described or pictured as "for boys" or "for girls." For example, a chemistry set that only pictures boys is stereotypic; a book about growing up that is listed as "for boys" is not necessarily stereotypic although it may have stereotypes in it" (Campbell & Storo,

1994).

Investigating the existence and effects of gender stereotypes on math performance is the basis of an article by Thompson (2001).

Ms. Thompson asks the question, "Are women as good at math as men?"

She looks to Diane Quinn for an answer, "According to Diane Quinn, an assistant professor of psychology, the mere fact that many people think the answer is "no" may itself account for the gender disparity on standardized math tests."

The professor and a colleague conducted two studies to examine the theory. Professor Quinn states, "There aren't genetic differences, so we wanted to know what's going on."

In the first study Professor Quinn and her colleague, Steven J. Spencer (2001) "found that if they could make the stereotype disappear the gender difference went with it." In the first study, "Some 54 male and 54 female college students were each given a multiple-choice math test. Half the students received an exam with word problems; the other half got the same material, but it had been converted to numerical equations. Quinn and Spencer found that women and men scored the same when the problems were expressed only in numbers. But on the word problems, men scored better."

As a result the researchers conclude, "This study demonstrates that women have the mathematical skills and knowledge necessary to solve the problems. Something interfered, however, with the women's ability to strategize and convert the problems when they completed the word problem test."

Further investigation concludes that, "According to the researchers, the high level of "stereotype threat," which occurs when a person is in a situation where a negative

stereotype could be used to judge their behavior, impaired the performance of the women who took the word problem test."

The second study revealed a situation that is probably not often considered. " In a second study, the researchers manipulated stereotype threat in order to determine whether that was the variable interfering with women's mathematic abilities. In that study, 36 college students who scored between 650 and 700 on the math portion of the SAT were given a test of multiple-choice word problems. Half the students were told that prior use of the test had shown that men and women did equally well on the problems. The others weren't given any instruction about gender stereotypes. All the participants were asked to think out loud while solving the problem. The researchers found that when participants weren't given any instructions about gender stereotypes, women under performed when compared to men, and were less likely to be able to formulate strategy. When participants were told that the test was gender-neutral, men and women performed equally well and didn't differ in their ability to formulate and use strategies."

From the research Quinn and Spencer draw these conclusions. "We conclude from these two studies that the knowledge of cultural stereotypes changes the testing situation for women, such that their performance is depressed." Quinn and Spencer further state, "If parents and teachers became more aware of the many subtle ways they may shape math situations for girls and women, then we believe even greater changes could be made in women's attitudes towards math and their math performance. Indeed, if girls and women encounter fewer situations in which they experience stereotype threat, their increasing performance may one day break the ugly cycle of the stereotype leading to poor performance and the poor performance in turn feeding the stereotype"

(Thompson. 2001).

Another article that addresses gender stereotype begins to explore gender stereotypes within children's adolescent years of development. The article by Derewitz (1998), begins by explaining how gender stereotypes are formed. "By nature, men and women have some biological differences, but it is life experience that reinforces or contradicts those differences (Basow, 1980). The truth lies in differential socialization, which claims that males and females are taught different appropriate behaviors for their gender (Burn, 1996). This begins at such an early age that children fully understand how to act according to their gender by age five or six (Basow, 1980). Two major role players in gender stereotype formation tend to be parents and teachers. "A child's parents are some of the first socialization agents he or she will come into contact with. Parents teach stereotypes through:

1 The way they dress their children
2 The way the decorate their children's rooms
3 The toys they give their children to play with
4 Their own attitudes and behaviors

(Hetherington and Parke, 1999)

Gender stereotypes are taught in academic settings, though perhaps unconsciously. Studies have shown that teachers generally give more one-on-one attention to male students, while giving females very little feedback (Basow, 1980). Additionally, they reinforce stereotypes through phrases such as "good girl" or "good boys don't do that," leading a child to believe that

his or her behavior will always be judged upon the basis of his or her gender (Burn, 1996)." The author points to different psychological explanations of internalization of gender stereotypes:

1 Psychoanalysts claim that they stem from the child's identification with his or her same-sex parent.

2 Social learning theorists claim that children copy what they observe to be appropriate.

3 Cognitive theorists believe that the child learns what sex he or she is, and then adopts behaviors that are consistent with that gender.

(Papalia, Olds, & Feldman, 1998)

The article begins to address academic stereotypes by stating, "For both males and females, stereotypes can lead them to deny natural talents they have if the are not concordant with what is appropriate (Papalia, Olds, & Feldman, 1998). They fear succeeding in a specific field if there will be any negative associations with it (Basow, 1980). [As an] example, females in high school generally do much worse than males in mathematics. This can be explained by the fact that math is usually seen as a subject for males, so adults do not encourage females to succeed as much in this area. The girls themselves may feel that if they do well, they will be looked down upon as going against the norms. If they don't think they should succeed, they probably will not, thereby falling victim to a self-fulfilling prophecy (Burn, 1996)."

The author concludes, "It may be surprising that gender stereotypes have such a huge impact on every adolescent's life. Stereotypes begin to form at an extremely early age and are reinforced through parents, teachers, and media. Stereotypes come out in

jokes and name-calling among adolescents. The strict gender criteria can lead to great conformity and less academic opportunities. Though the overall impact of gender stereotypes seems to be lessening, it is easy to see that there is still a long way to go until equality is reached" (Derewitz, 2005).

To reinforce the idea that gender stereotypes affect attitudes toward the study of mathematics, Bleeker (1992), conducted a major study of gender stereotypes in math and science. The study begins laying a foundation by citing previous research, "Previous research has shown:

1 Parent's beliefs are related to children's achievement
2 Self-perceptions of ability, interest, and values are related to later achievement motivation
3 Age-related trends are evident
4 Interest is especially important

(e.g., Jacobs & Eccles, 2000; Wigfield & Eccles, 1992)

The author addresses parental influence on gender stereotypes, "Parents' Gender Stereotypes…

1 Influence the ways in which they interpret their children's performance
2 Correspond with more positive perceptions of sons' abilities in math and science, compared to daughters
3 Influence children's self-perceptions and grades, carrying more weight than previous performance

(Bleeker & Jacobs, under review; Jacobs, 1991; Jacobs & Eccles, 1992)

The research conducted contains a description of the sample study and it closely

resembles the sample that was studied for this action research. "Description of Sample:

1 Data from the Childhood and Beyond (CAB) longitudinal project collected between 1989 and1999.

2 Cross-sequential design. 3 cohorts (n=761) were followed across elementary, middle, and high school years.

3 Original sample was 53% girls and 47% boys; proportions remained the same throughout the waves of data collection.

4 Children were from middle class backgrounds with average family income of $50,000 in 1990. Over 95% of the children were European-American.

(Bleeker, 2005)

Measures used were:

1. Parents' Reports (Year 2-4)
    - Perceptions of children's abilities
    - Gender stereotypes (about math)
    - Involvement in math/science activities with children
    - Number of math/science toys purchased for children in past year

2. Children's Reports (Year 3-5)

    2 Interest and self-perception of math/science ability, math/science GPA

    (Bleeker, 2005)

Analysis was conducted with different instruments.

3 Repeated measure ANOVA's to detect gender and grade differences in parents' involvement with children

4 One-way ANOVA's to detect gender differences in toy purchases

5 Stepwise regression analyses examining the significance of parents' gender stereotypes and purchases

In summarizing the statistical results of her research Ms. Bleeker found that sexual stereotypes exist and they do affect female performance and self-perception in mathematics. Parents Interpret Child's Experiences: Parents' perceptions of children's abilities were related to later interest in math. Fathers who reported stronger gender stereotypes had sons who reported more interest in math, and daughters who reported less interest. Parents Provide Opportunities: Families were more likely to purchase math and science items for sons than for daughters, regardless of child's grade in school. Children whose parents purchased more math and science toys had higher GPA's, interest and activity involvement in later years. Parents' Involvement in Activities: Parents' involvement in math/science activities with children varied by child's grade in school, with involvement decreasing over time. Mothers were more likely than fathers to be involved in science/math activities from 1 – 3rd grade. Mothers were more likely to be involved in daughters' than sons' math/science activities. Parents as Role Models: Parents' modeling and purchases are positively related to children's later math/science activities.(Bleeker, 2005)

In an article written by McKinney (1998), the author addresses gender inequities in his introduction, "Gender inequities have plagued education for many years. It existed before the introduction of computers into schools and the almost overwhelming surge of computers in the workplace. Girls have traditionally avoided mathematics and science courses in school, and this reluctance has extended to the use of technology as well

(Bohlin, 1993). Computer use has been perceived as being related to math and science skills, thus more necessary for boys than girls (Kirk, 1992). Gender inequities in mathematics and science have been studied longer than technology issues and may offer insight into causes and remedies regarding computer use and gender" (McKinney, 1998).

An exploration of gender stereotype in mathematics is outlined, "Since the 1970s, educators and researchers have attempted to increase the number of girls enrolled in math and science courses. Their efforts met with some success. Girls are now taking three or more years of mathematics and science courses in high school, more than ever before (Meece & Jones, 1996). Furthermore, the well-documented gender gap has narrowed for these subjects over the last 20 years. Because of this, many people believe that the gender issues have been resolved. This is simply not true. Even though the number of girls taking mathematics and science courses has increased, girls are still not achieving their potential in these subjects. Girls often do not raise their hands to answer, even when they know their right (Pipher, 1994). This is not from shyness but rather a result of a lifetime of being treated differently than their male counterparts. The American Association of University Women (AAUW)(1992) asserts that girls are treated not only differently in the classrooms but unfairly as well. For example, teachers wait longer for boys to answer than they do girls, teachers give more encouragement to boys than to girls, teachers call on boys more than they do girls, teachers pose more challenging questions to boys than to girls, and teachers are more likely to recognize answers called out by boys than by girls. These subtle messages are internalized by both genders such that by the 11th grade, 29 percent of the girls and 40 percent of the boys believe gender differences in cognitive abilities are innate. Only 17 percent of students at this age level believe the differences

were caused by societal influences (Cummings, 1994; Meece & Jones, 1996). This internalizing is further compounded by what Steele and Aronson (1995) call the Stereotype Threat. Negative stereotypes of girls' performance in mathematics and science abound, and when a girl is at risk of confirming the stereotypes as a self-characterization of herself and others, her performance is often hindered to the point that the stereotype is confirmed. Sex Stereotypes directly influence math and verbal self-concepts in addition to indirect effects through achievement scores (Marsh, Byrne, & Shavelson, 1988).

Even though the research points to socialization by parents as a factor in student perceptions of the study of mathematics, that would require a broader study and will not be addressed in this action research project. The research clearly shows that student perception of the study of mathematics varies based on performance levels and self and gender perception. Research leans heavily towards gender stereotypes as influencing both male and female perceptions and attitudes toward the study of mathematics. The different attitudes exist not only within our classrooms, but also within our society as a whole. The research points primarily to gender stereotypes and their effects in adolescent through young adult education, however many references are made to the fact that gender stereotypes are observed and internalized at a very early age. It is documented that differentiated instruction increases student achievement, which in turn increases positive self-perception in the course of the study of mathematics. To draw a conclusion it can be said that students' attitudes of the study of mathematics can be greatly influenced by many factors one of which is the style of teaching practices utilized.

Chapter III
Procedures

This study sample includes two classes. The control group consists of sixteen students; eight girls and eight boys that will not receive treatment. The treatment group consists of eight girls and seven boys. A pre-test was administered to determine students' attitudes toward the study of science and mathematics in both classes. The test was the "Modified Fennema-Sherman Attitude Scale."

In February, the pretest was administered to the control group and the treatment group. The treatment was administered. Report cards were distributed at the end of a six-week marking period. Students completed the post-test and results were tabulated. In the eighth week, independent T tests were run on data collected from the control group and the treatment group. No statistical significant change was found.

Students of both the control group and the treatment group completed the "Modified Fennema-Sherman Attitude Scale," as a pretest. I made categorical tabulations by computing mean scores of every student from both groups. I then tested the treatment group for their modalities and learning styles. Based on the results of these two tests differentiated the math curriculum for the treatment group utilizing the modality and learning preference information, tiered lessons, and differentiated activities. During the course of the six-week marking period, I implemented specific differentiated tiered lessons and activities. Students continued to be assessed but "bonus" questions were included that appealed to the students' different learning styles and that enriched the curriculum. Any remediation was performed with modalities and learning preferences factored in to the lesson.

The non-treatment group was taught as required by the standard mathematics curriculum, Everyday Mathematics. No differentiated activities were implemented and assessments were also dictated by the curriculum. Only direct instruction was implemented without differentiation.

At the end of the six-week marking period the treatment group and the non-treatment group received their report cards and all final assessments. Upon receipt of their report cards, the students of both classes completed the "Modified Fennema-Sherman Attitude Scales" for attitudes toward mathematics as a post-test. It was explained to the two classes, for the pre and post-tests, that the tests were surveys and that they assessed opinions and whether or not those opinions had changed or stayed the same. Furthermore students were made aware that no grade would be associated with any of the tests and that there were no correct or incorrect answers.

Post-test results from the two groups were again tabulated by the four categories and mean scores for each student were computed. T tests were computed on the change of the means from pre to post-tests for both classes to test for statistical significance. The results of the pre and post-tests Ts were evaluated and compared between the treatment group and the control group. Conclusions were drawn as to whether or not differentiation of fourth grade math instruction changed student perceptions of the discipline. T tests were run using the SPSS student version 13.0 program. The analysis of the data was done with two independent sample T tests with a margin of error of 0.05. Results were computed into graph form. T test results showed no statistically significant change in students' attitudes toward the study of mathematics in either the control group or the treatment group.

Chapter IV

Findings

During the course of the pre and post-tests and the implementation of the treatment, adjustments were required to decrease threat levels. Upon further research the Modified Fennema-Sherman Attitude Scales met with some documented criticism about language. After evaluating the criticism I decided that as an attitudinal scale the Modified Fennema-Sherman Attitude Scale was best suited to discern the fourth-grade students' perceptions of the study of mathematics. The language was direct and on or below the students' reading levels. The A through E scale was simple to understand and relate to. The impact of differentiated teaching upon students' attitudes toward math should be further investigated. The study should extend over a longer period of time. The same age group could be used again as the students were capable, cognitively, of completing the self-assessments with little to no assistance. Reading levels, of both classrooms, ranged from grade five to grade twelve. Subsequently, the language of the instrument posed no threat. I administered the test to both the treatment group and non-treatment group in order to be consistent. I administered both of the pre-tests on February 7, 2006. Following the treatment I administered the post-tests on March 22, 2006.

I made some adjustments in administering the survey. I asked the students to read along as I read the instructions on page one of six. I then illustrated, on a white board, what the letters A through E meant in relationship to the questions. I told the students that they could mark their answers any way that they liked as long as they only marked one answer per question. I emphasized that there were no correct or incorrect answers and that the test was only a survey of their opinions. During the course of the test description

I sensed a level of apprehension about answering opinion questions truthfully. Many of the students in the fourth grade have a well-developed sense of empathy and a few appeared reluctant to "hurt" my feelings. Sensing a threat to authenticity and reliability, I added that no names were to be put on the tests only some indication as to the gender of the test taker i.e. F or M, female or male, etc. I gave no time limit for the test and a typical silent testing situation evolved. During the course of the pre-tests there were some questions about the meanings of certain questions. I asked if the student understood what the question asked as opposed to why the question was asked. Universally the students had no problems with decoding and understood what all questions meant. Some students noticed that some questions seem to be repeated but in a different context. I simply responded that the test also measured consistency of answers.

The pre-test was administered on the day originally determined. I administered all tests and there was 100% attendance for both classes. The post-test date was pushed back because of a series of sicknesses in both classes. The treatment class had a continued treatment until the post-test could be administered on 22 March. The extended treatment time posed no internal or external threats and there was 100% attendance for the testing on 22 March.

I tabulated the means of the self-assessments for each student of the control group and the treatment group. I ran T-tests comparing the pre-test means to the post-test means for both groups. With a significance factor of 0.05 the T-tests showed that there was no statistical difference in the pre and posttests of both the control group and of the treatment group. Based on these findings, I concluded that the implementation of differentiated teaching practices does not significantly change attitudes toward the study.

Chapter V

Conclusions

Based on the results of this action research project, there appears to be no statistical significance in the change of attitudes towards the study of mathematics in fourth grade students when mathematical curriculum is differentiated. Due to the results of the T tests, the null hypothesis that differentiation of fourth grade math instruction does not change perception of the discipline was accepted. Upon reflection, a more accurate study would begin at the beginning of the school year and finish at the end of the school year. Measuring fourth grade student perception of the study of mathematics may require a multiple year treatment and assessment.

The Modified Fennema-Sherman Mathematics Attitude Scale has been questioned professionally for its accuracy in measuring attitudes towards the study of mathematics. A more current and field tested measuring instrument could be located and used for future studies on this subject. A larger sample group that is more diverse could be used to give a broader spectrum of analysis. Findings of this study show that differentiated instruction does not improve students' attitudes toward the study of mathematics. Implementation of differentiation, however, does not negatively impact students' attitudes toward the study of mathematics. Students' survey scores were universally high in the pre-tests, leaving very little margin for a change in a positive direction. Had students' initial survey scores been lower, there would have been a larger margin for improvement. During the course of the study, students were excited and engaged with the differentiated math lessons and activities. My daily observations lead me to conclude that even though the survey did not show an overall attitudinal change

toward the study of mathematics, the students' participation became more active and engaged.

Students in the treatment group responded well to differentiated instruction. Students reported frequently that they enjoyed the lessons implemented during the course of the study. In all cases, the treatment group maintained or improved their academic assessment scores. I believe that the abbreviated treatment of six weeks was not sufficient to change the students' attitudes dramatically toward the study of mathematics. Also, I believe students' perceptions towards the study of mathematics had been forged during the course of their elementary education and would take longer than six weeks of implemented differentiated lessons to change with statistical significance.

The measurement of attitudes of fourth grade students can seem to be a precarious and sometimes ambiguous subject for research. The treatment group responded well to the implementation of differentiated teaching practices. While the attitudinal survey shows no shift in students attitudes towards the study of mathematics, the paradigm of student attitudes requires a more lengthy study as an action research. Over a prolonged period, with the implementation of differentiated teaching practices, student attitude toward the study of mathematics may show a significant statistical change.

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Appendix A
Statistical Information and Graphs

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
TREATPRE	15	51.2500	3.89826	1.00653
TREATPOS	15	50.7000	5.18084	1.33769

One-Sample Test

	Test Value = .05					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
TREATPRE	50.868	14	.000	51.2000	49.0412	53.3588
TREATPOS	37.864	14	.000	50.6500	47.7809	53.5191

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
TREATPRE	15	51.2500	3.89826	1.00653
TREATPOS	15	50.7000	5.18084	1.33769

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
TREATPRE	50.918	14	.000	51.2500	49.0912	53.4088
TREATPOS	37.901	14	.000	50.7000	47.8309	53.5691

Graph

T-Test

One-Sample Statistics

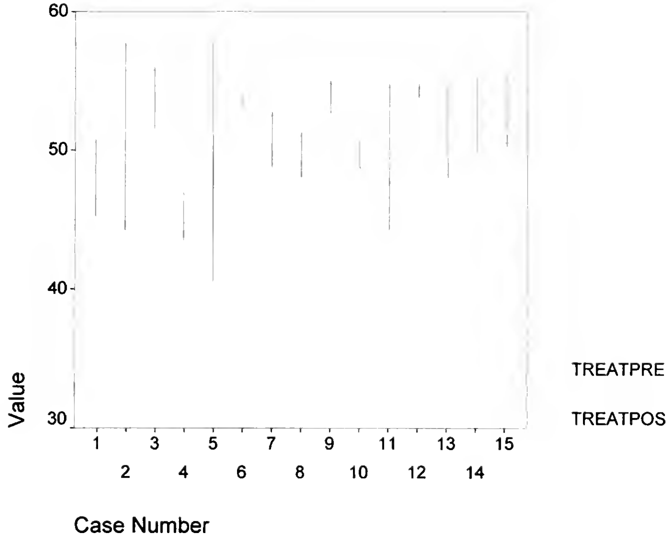
	N	Mean	Std. Deviation	Std. Error Mean
TREATPRE	15	51.2500	3.89826	1.00653
TREATPOS	15	50.7000	5.18084	1.33769

One-Sample Test

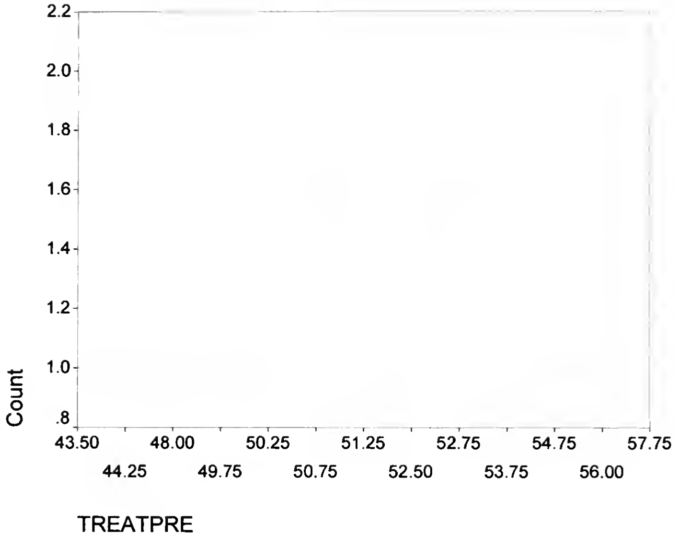
	Test Value = .05					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
TREATPRE	50.868	14	.000	51.2000	49.0412	53.3588
TREATPOS	37.864	14	.000	50.6500	47.7809	53.5191

T-Test

Graph



60
50
40
30
Value
1
3
5
7
9
11
13
15
2
4
6
8
10
12
14
Case Number
TREATPRE
TREATPOS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2.0
1.8
1.6
1.4
1.2
1.0
.8
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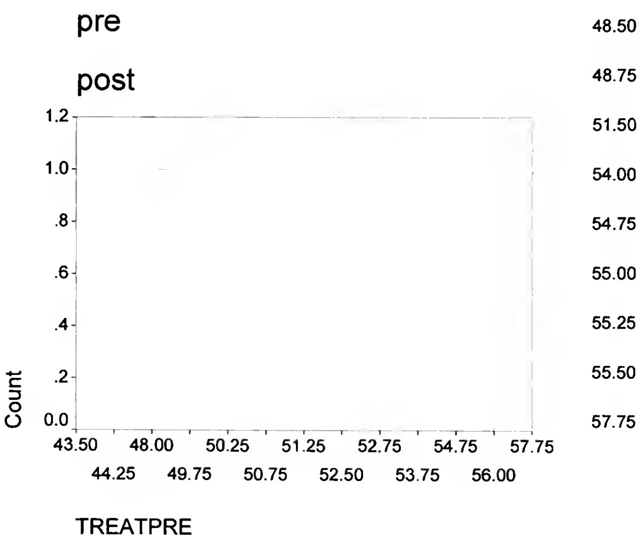
44.25
48.00
49.75
50.25
50.75
51.25
52.50
52.75
53.75
54.75
56.00
57.75
TREATPRE

Graph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post
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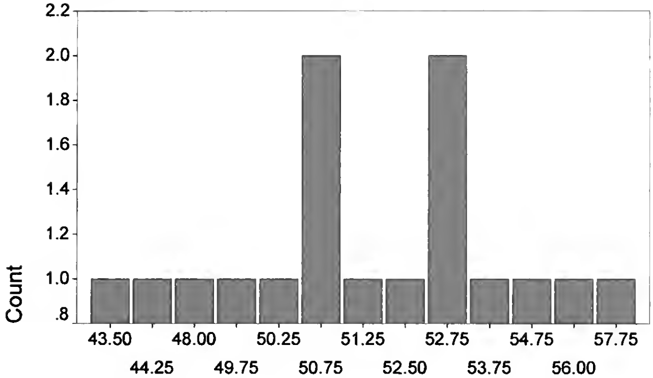
48.75
51.50
54.00
54.75
55.00
55.25
55.50
57.75
1.2
1.0
.8
.6
.4
.2
0.0
Count
43.50
44.25
48.00
49.75
50.25
50.75
51.25
52.50
52.75
53.75
54.75
56.00
57.75
TREATPRE

Graph

pre

post



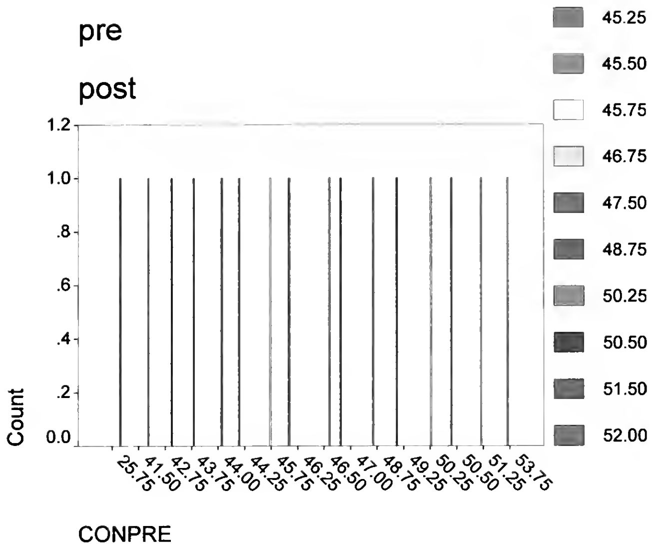
TREATPRE

T-Test

One-Sample Test

	Test Value = 0.05					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
CONPRE	28.945	15	.000	45.6531	42.2914	49.0149
CONPOST	18.310	15	.000	43.5125	38.4472	48.5778

Graph


pre
post
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46.75
47.50
48.75
50.25
50.50
51.50
52.00
Count
1.2
1.0
.8
.6
.4
.2
0.0
25.75
41.50
42.75
43.75
44.00
44.25
45.75
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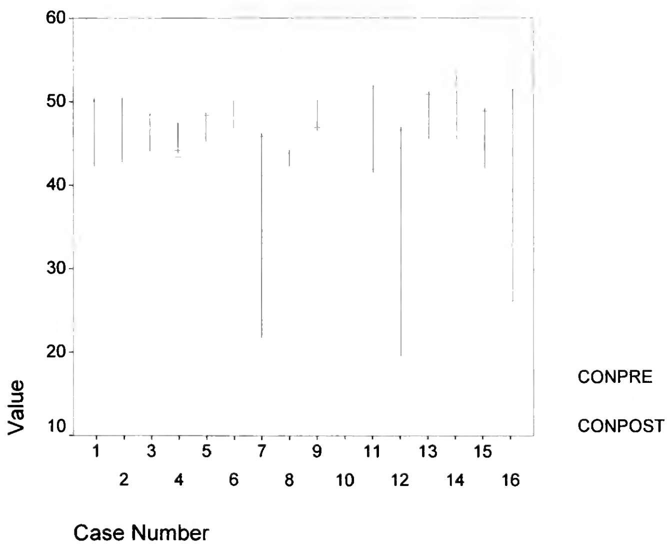
46.50
47.00
48.75
49.25
50.25
50.50
51.25
53.75
CONPRE

Graph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30
20
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12
14
16
Case Number
CONPRE
CONPOST

Appendix B
Tools for Differentiation

Name ______________________________

Activity 2.5 – The Modality Preferences Instrument (HBL, p. 23)

Follow the directions below to get a score that will indicate your own modality (sense) preference(s). This instrument is just one of many available, and you should not rely on just one instrument for self-assessment. Keep in mind that sensory preferences are usually evident only during prolonged and complex learning tasks.

Identify Sensory Preferences

Directions: For each item, circle "A" if you **agree** that the statement describes you most of the time. Circle "D" if you **disagree** that the statement describes you most of the time.

1.	I prefer reading a story rather than listening to someone tell it.	A	D
2.	I would rather watch television than listen to the radio.	A	D
3.	I remember names better than faces.	A	D
4.	I like classrooms with lots of posters and pictures around the room.	A	D
5.	The appearance of my handwriting is important to me.	A	D
6.	I think more often in pictures.	A	D
7.	I am distracted by visual disorder or movement.	A	D
8.	I have difficulty remembering directions that were told to me.	A	D
9.	I would rather watch athletic events than participate in them.	A	D
10.	I tend to organize my thoughts by writing them down.	A	D
11.	My facial expression is a good indicator of my emotions.	A	D
12.	I tend to remember names better than faces.	A	D
13.	I would enjoy taking part in dramatic events like plays.	A	D
14.	I tend to think in sounds.	A	D
15.	I am easily distracted by sounds.	A	D
16.	I easily forget what I read unless I talk about it.	A	D
17.	I would rather listen to the radio than watch television.	A	D
18.	My handwriting is not very good.	A	D
19.	When faced with a problem, I tend to talk it through.	A	D

20. I express my emotions verbally. A D

21. I would rather be in a group discussion than read about a topic. A D

22. I prefer talking on the phone rather than writing a letter to someone. A D

23. I would rather participate in athletic events than watch them. A D

24. I prefer going to museums where I can touch exhibits. A D

25. My handwriting deteriorates when space becomes smaller. A D

26. My mental pictures are usually accompanied by movement. A D

27. I like being outdoors and doing things like biking, camping, swimming, hiking, etc. A D

28. I remember best what was done rather than what was seen or talked about. A D

29. When faced with a problem, I often select the solution involving the greatest activity. A D

30. I like to make models or other hand-crafted items. A D

31. I would rather do experiments rather than read about them. A D

32. My body language is a good indicator of my emotions. A D

33. I have difficulty remembering verbal directions if I have not done the activity before. A D

Interpreting the Instrument's Score

Total the number of "A" responses in items 1-11: ____________
This is your visual score.

Total the number of "A" responses in items 12-22: ____________
This is your auditory score.

Total the number of "A" responses in items 23-33: ____________
This is your tactile/kinesthetic score.

If you scored a lot higher in any one area: This indicates that this modality is *very probably* your preference during a protracted and complex learning situation.

If you scored a lot lower in any one area: This indicates that this modality is *not likely* to be your preference(s) in a learning situation.

If you got similar scores in all three areas: This indicates that you can learn things in almost any way they are presented.

Triarchic Theory of Intelligences
Robert Sternberg

Mark each sentence T if you like to do the activity and F if you do not like to do the activity.

1. Analyzing characters when I'm reading or listening to a story ____
2. Designing new things ____
3. Taking things apart and fixing them ____
4. Comparing and contrasting points of view ____
5. Coming up with ideas ____
6. Learning through hands-on activities ____
7. Criticizing my own and other kids' work ____
8. Using my imagination ____
9. Putting into practice things I learned ____
10. Thinking clearly and analytically ____
11. Thinking of alternative solutions ____
12. Working with people in teams or groups ____
13. Solving logical problems ____
14. Noticing things others often ignore ____
15. Resolving conflicts ____
16. Evaluating my own and other's points of view ____
17. Thinking in pictures and images ____
18. Advising friends on their problems ____
19. Explaining difficult ideas or problems to others ____
20. Supposing things were different ____
21. Convincing someone to do something ____
22. Making inferences and deriving conclusions ____
23. Drawing ____
24. Learning by interacting with others ____
25. Sorting and classifying ____
26. Inventing new words, games, approaches ____
27. Applying my knowledge ____
28. Using graphic organizers or images to organize your thoughts ____
29. Composing ____
30. Adapting to new situations ____

Triarchic Theory of Intelligence
Key

Transfer your answers from the survey to the key. The column with the most True responses is your dominant intelligence.

Analytical	Creative	Practical
1. _____	2. _____	3. _____
4. _____	5. _____	6. _____
7. _____	8. _____	9. _____
10. _____	11. _____	12. _____
13. _____	14. _____	15. _____
16. _____	17. _____	18. _____
19. _____	20. _____	21. _____
22. _____	23. _____	24. _____
25. _____	26. _____	27. _____
28. _____	29. _____	30. _____

Total Number of True:

Analytical ________ Creative _______ Practical _______

N. Smith (2004)
Adapted from Sternberg, R. & Grigenko, E. (2000)Teaching Successful Intelligence. and K. Brimijoin (2001)